

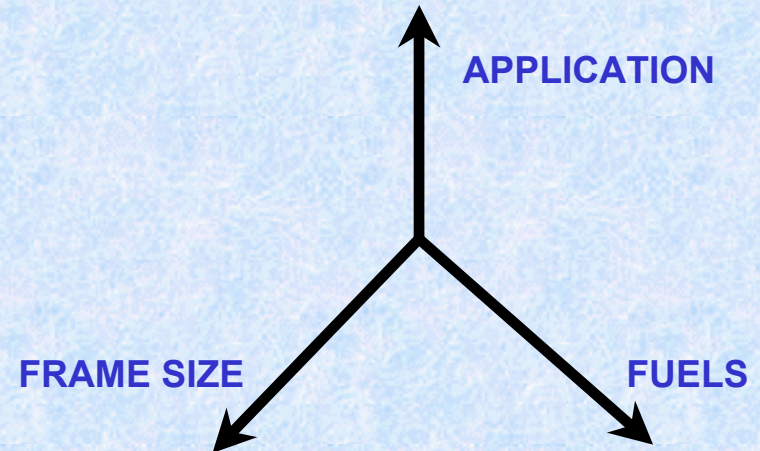
Microturbine Development at Elliott Energy Systems

Dave Dewis
VP of Engineering

Development Strategy

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- For our Industry all Development efforts are Business focused. As the business changes so does the direction:
- EES has a structured approach that moves along three axes.
- Within this framework technical direction is determined by potential Revenue Generation.
- Core Technology improvements are an ongoing activity aimed at improving efficiency, reducing emissions, and reducing cost.

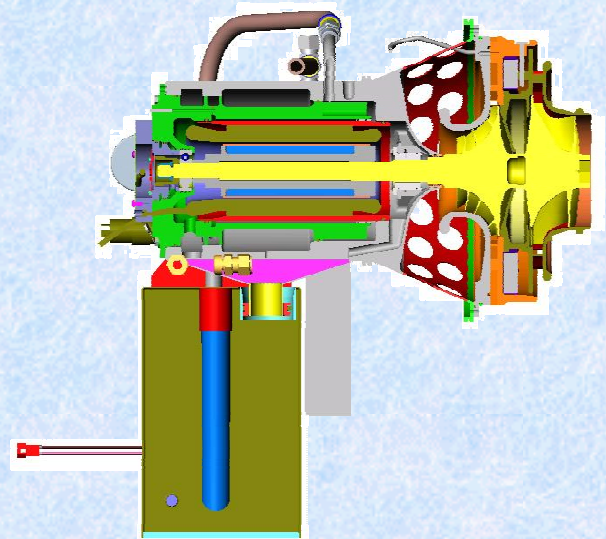


Product Improvements

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Power Head Module

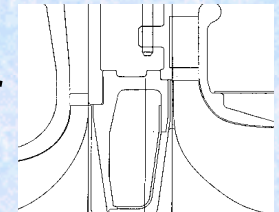
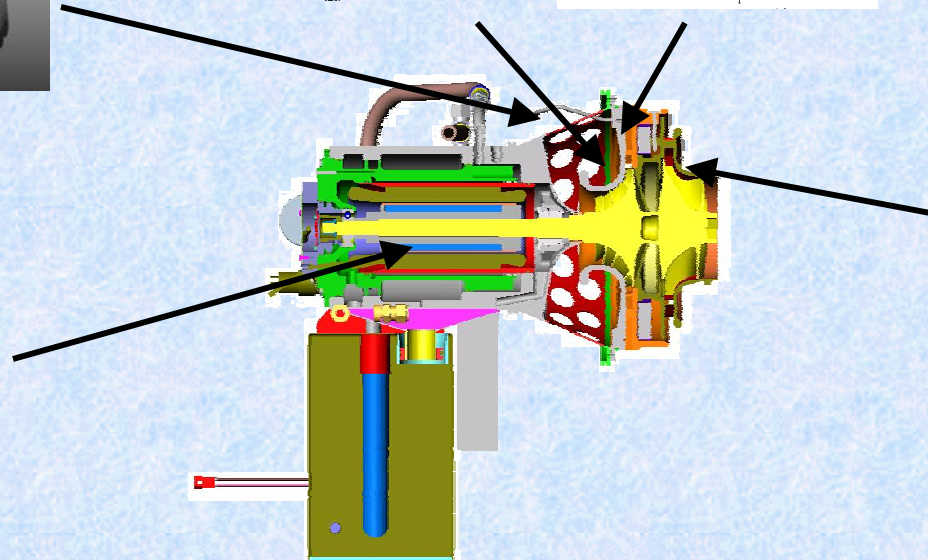
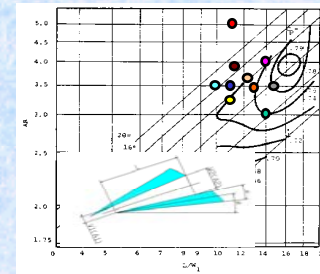
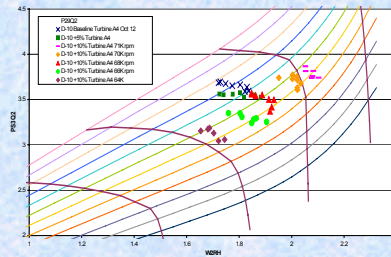
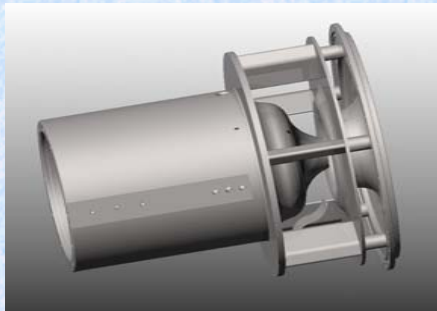
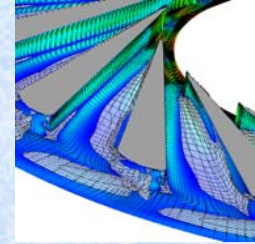
- Aero Thermal Improvements incorporated raised efficiency from 28% to 30% electrical efficiency.
 - EGT and TIT reduced
 - Output limited by PMG
- Increased rating of PM Generator raises output to 100Kw.
 - Increased footprint power density
 - 25% cost reduction of power head.



Product Improvements

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Power Output Increased 25%
Efficiency Increased to 30%

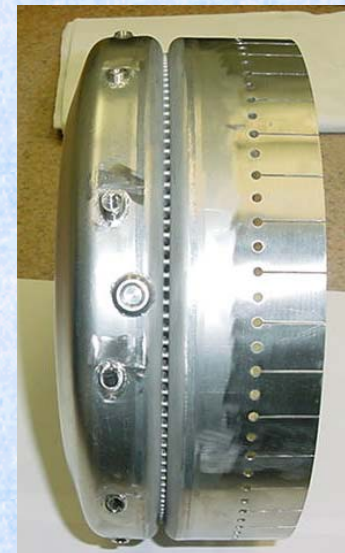


Product Improvements

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Combustor Liner

- Manufacturing Process improvements have yielded significant reduction in flow variations.
 - Reduced pattern factor
 - Improved primary zone Φ
- CFD and testing has reduced emissions.
 - $\text{NO}_x < 20\text{ppm}$
 - $\text{CO} < 30\text{ppm}$



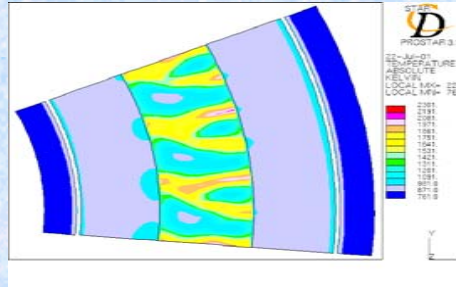
Microturbine Equipment Panel

Product Improvements

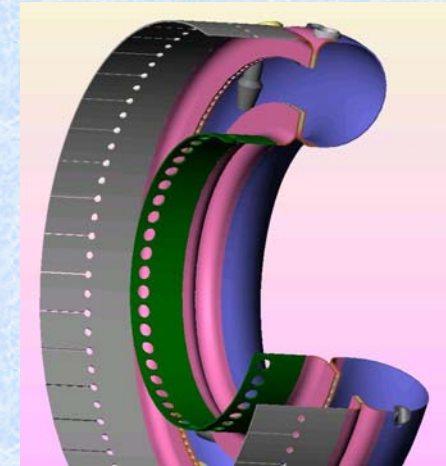
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Flow Bench Testing

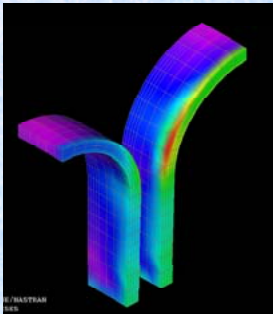


CFD



Parametric Models

FEA



Brazed Dam Liner

Process Improvements



Microturbine Equipment Panel

Product Improvements

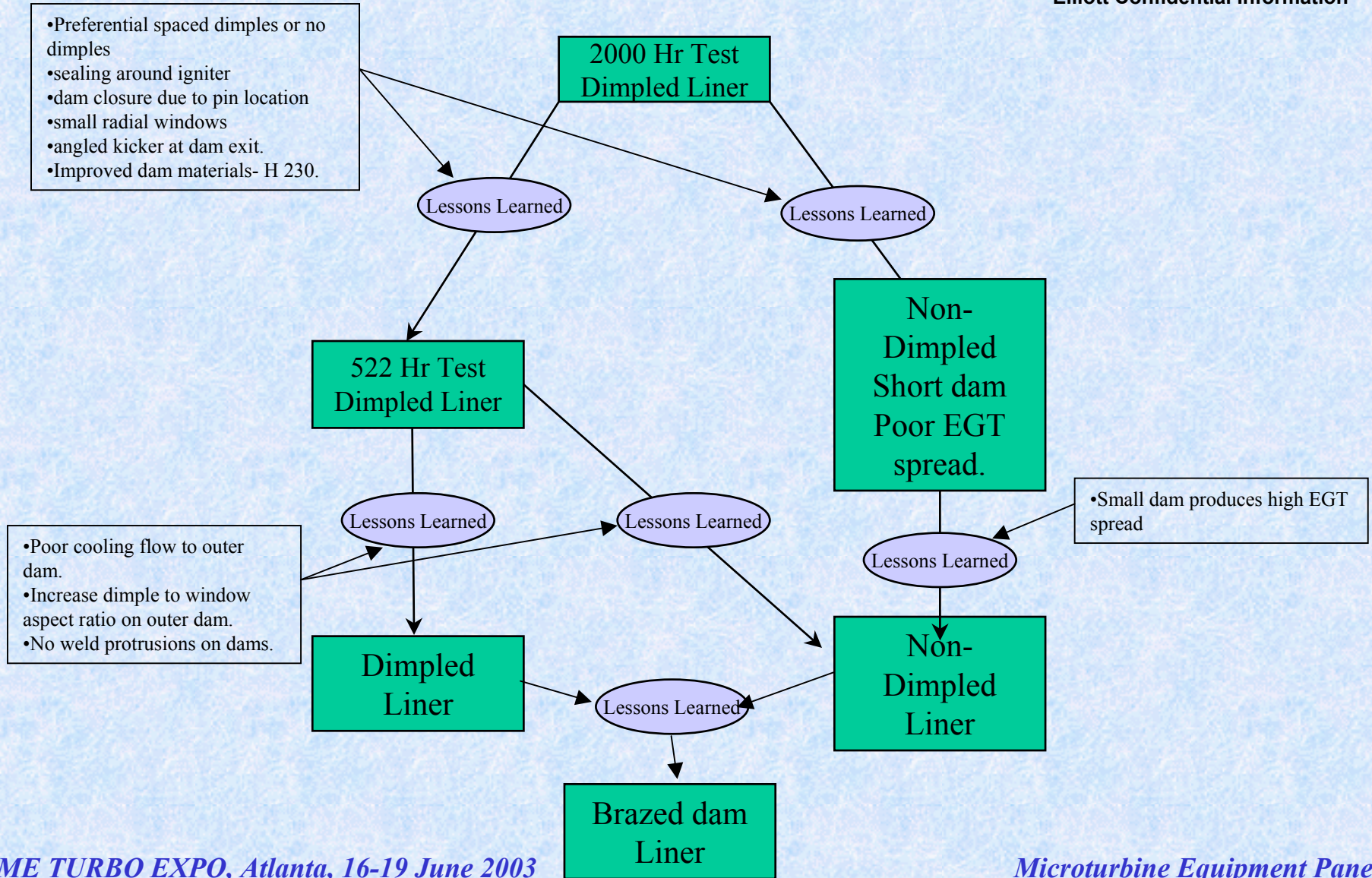
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500 Cycle Liner Endurance Test



Combustor Liner Development

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Outsourced Recuperator

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Recuperator Improvements

- Integrated electrical efficiency increased from 26.5% to 29%.
 - Increased cell count
 - Added heat shields.
- Reduced package size to conform to envelope constraints.
- Development ongoing to:
 - Reduce height
 - Characterize thermal distribution.

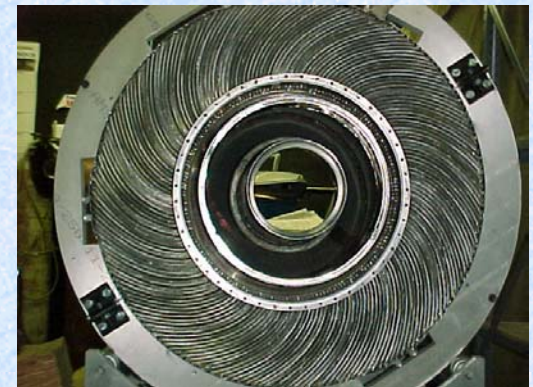
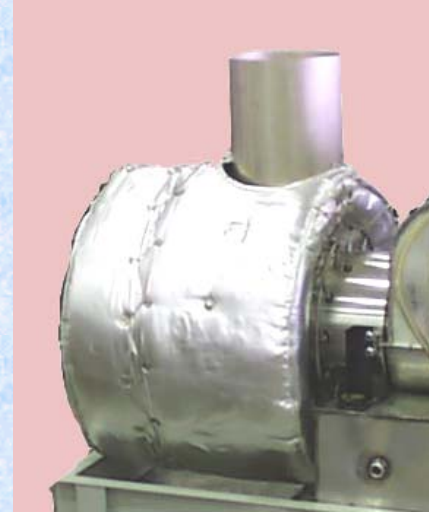


Annular Recuperator

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Recuperator

- Development of the EES annular has been completed.
 - Integrated engine efficiency 29%
 - Thermal distribution improved.
 - Significant Cost reduction.



Package Development

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Standard Enclosure



Low Noise Enclosure



Package Development

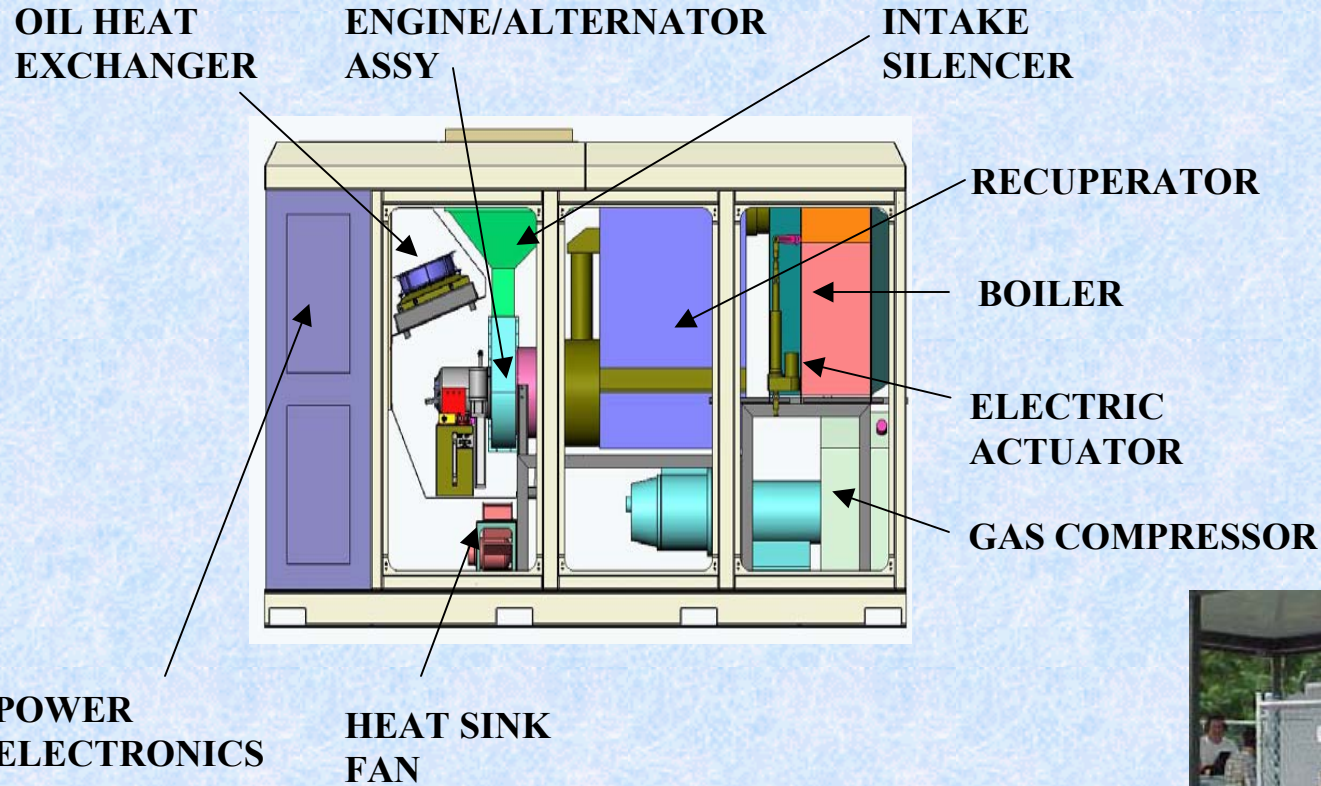
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MonoGen with EES recuperator

TA100RG CoGen Package

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Direct-Fired Absorption Chiller

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Assembled Unit



Side View



Front View



Low BTU Landfill Testing

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